Effects of Age and a Divided Attention Task Presented During Encoding and Retrieval on Memory[1]

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Remembering frequently occurs in the context of other competing activities. When trying to encode or retrieve information in everyday situations, we often do so amidst ongoing relevant and irrelevant information and concurrent events. This array of competing contextual stimulation may capture our attention and interfere with our ability to remember efficiently the information on which we would like to focus. In the present studies, we examined the effects of divided attention in a long-term memory task and looked at differences in the degree to which subjects of different ages were affected by this distraction. We were particularly interested in whether there were age-related differences in the effect of competing tasks during encoding, during retrieval, or during both.

A great deal of research has been done on age differences in performance on working memory tasks (tasks that involve the processing of information held in primary memory) as a function of divided attention. A number of researchers have reported that elderly adults are more disadvantaged than young adults by the addition of a secondary task while engaged in a working memory task (Baddeley & Hitch, 1974; Salt-house, Rogan, & Prill, 1984; McDowd & Craik, 1988), particularly when the difficulty or complexity of the working memory task is increased. Others, however, have failed to find evidence for these interactions (Somberg & Salthous, 1982), even when complexity has been manipulated (Gick, Craik, & Morris, 1988; Morris, Gick, & Craik, 1988). Thus, there is some question as to the nature of the conditions under which such age interactions are observed, even in working memory paradigms (Gick et al., 1988).

Research on the effects of divided attention on the encoding phase of long-term memory is more limited. Park, Puglisi, Smith, and Dudley (1987) reported little evidence that a divided attention task present at encoding affected old and young adults differently in a recognition paradigm. However, Puglisi, Park, Smith, and Dudley (1988) did find some evidence that elderly subjects were more disadvantaged than younger subjects by the addition of such a task during encoding with word recall as the dependent measure but did not find such a disadvantage for the recall of

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pictures. These data suggest that stimulus variables play a role in the effects of divided attention with different age groups, and that, as in the working memory literature, age interactions with a divided attention task may not always be observed.

The effect of presenting a divided attention task at retrieval, and whether its presence or absence interacts with age, is even less clear because there are few data in this area, even with only young adults as subjects. In one experiment with college students, Johnston, Wagstaff, and Griffith (1972) had subjects detect a visual stimulus while both encoding and recalling a nine-word list presented repeatedly across trials. Reaction time to the visual stimulus was longer for uncategorized lists at recall, suggesting that uncategorized lists required more effort to retrieve than categorized lists. Johnston et al. also reported that the effect of the visual task at encoding was of smaller magnitude than its effect at recall. As a result, the authors concluded that recall required more processing capacity than encoding. In a later study, using a different memory task than was employed in the 1972 research, Johnston, Griffith and Wagstaff (1972) reached a similar conclusion.

If the Johnston et al. (1972) conclusion is valid, one might expect elderly adults to be particularly vulnerable to competing demands at retrieval, because some researchers have argued that memory deficits evidenced by older adults are a function of limited processing resources (Rabinowitz, Craik, & Ackerman, 1982). There are two studies in the aging literature which have studied the relation among age, divided attention, and retrieval processes. Macht and Bushke (1983) had subjects free recall a list of words and simultaneously perform a visual detection task. The subjects pressed a response key when a light was turned on, averaging one every 15 s in a 1-min recall period. The competing task in this case was a very simple one, and in fact, failed to affect recall performance in either the young or old. However, reaction time did increase for the elderly on the detection task. This finding does provide support for the notion that older subjects find retrieval somewhat more effortful than young adults, but because of the low demands of the retrieval task, does not provide a clear assessment of the effects of divided attention on recall. In a similar vein, Craik and McDowd (1987) had subjects perform a four-choice reaction time task (decide if a target was a consonant or vowel if a letter was presented, and decide if it was odd or even if a number was presented) while the subject simultaneously attempted either cued recall or recognition of a previously presented word list. Craik and McDowd reported that performance on the concurrent reaction time task declined more for cued recall than for recognition. Moreover, the costs at recall were particularly high for older adults. Because of their primary interest in differences in effort associated with recognition versus recall, Craik and McDowd did not examine retrieval under conditions where there were no concurrent tasks, so the effects of adding a divided attention task to the retrieval performance of young and old cannot be determined from this study. The Craik and McDowd and the Macht and Bushke studies suggest that elderly adults' memory might be particularly disadvantaged by distraction at the time of recall, but for reasons mentioned above, this issue has not been directly addressed in the literature to date.

The present studies, therefore, were designed to determine how performance on a relatively demanding number-monitoring task affected recall performance of old and young adults when the task occured during encoding, during retrieval, or during both. The concurrent task used was a number-monitoring task modeled after one developed by Rabinowitz et al. (1982) and used successfully in past research with older adults (Park et al., 1986; Park et al., 1987; Puglisi et al., 1988). Morris et al. (1988) have suggested that use of a divided attention task that has a low error rate but high processing demands is ideal for use with young and old adults. The number-monitoring task met these criteria because previous results have shown that the addition of this task at the encoding phase of memory causes substantial declines in performance on a later retrieval task but that performance on the divided attention task itself is unaffected by either age or experimental conditions, because of nearly error-free performance on the number-monitoring task.

In Experiment 1, we examined the effects of the factorial manipulation of the number-monitoring task at encoding and retrieval on the free recall performance of old and young adults. The Craik and McDowd (1987) finding that recall was particularly effortful for elderly subjects suggested that a recall measure rather than recognition might be more sensitive to the addition of a divided attention task at the retrieval stage. Also, the Johnston et al. (1972) study suggested that organization and strategy use engendered by recall might be more disrupted by the secondary task because of the effortful nature of such processes. One hypothesis accounting for age differences in episodic recall is that older adults fail to engage in effective organizational processing and thus fail to retrieve the same number of items as do younger adults (Hultsch, 1975; Smith, 1980). Because of the likelihood that the processing requirements of a memory task may be important in determining the effects of an interference task, organizational processing was examined in Experiment 1. A categorized list of words was presented, and the extent of organization was measured by using clustering scores as an index of categorical organization. Experiment 2 was an extension of the procedures and manipulation used in Experiment 1, except that subjects were presented with a difficult cued recall task under conditions of speeded responding.

EXPERIMENT 1

METHODS

Subjects

A total of 126 subjects participated in this experiment, 64 young adults (mean age of 19.0 years) and 62 old adults (mean age of 72.3 years). The young adults were freshman and sophomore college students who participated to fulfill course requirements for undergraduate psychology courses. The older adults were healthy, active, community-dwelling individuals 60 years of age or older. The older adults received $10 for their participation. There were 41 females and 23 males in the young adults sample, whereas 52 females and 10 males comprised the sample of older adults. Subjects were administered the Gardner and Monge (1977) vocabulary test. This instrument is a measure of verbal ability that was selected for use over the Wechsler Adult Intelligence Scale (WAIS) because it can be easily administered to small groups and can be quickly scored. Like the WAIS, it has been standardized on both young and elderly adults and has a high degree of reliability (.90). Subjects' scores on this vocabulary test (with 30 as the maximum score) averaged 12.94 for the young and 20.19 for the elderly, a significant difference, $t(124) = 8.68$. This is a typical finding in cognitive aging research. The older adults were also more highly educated than the young adults, for the young were freshman and sophomores in college. Many of the older adults were retired university personnel, with 58.30% reporting that they had graduate degrees or had completed college; an additional 26.70% had some college education, while 10% were high school graduates, and 5% had less than a high school education. Subjects were also screened for visual acuity with a minimum corrected vision of 20/30.

Measures of forward and backward digit span were also collected, with the mean summed score for the young of 16.59, and for the old, 15.40—a difference that approached significance, $t(124) = 1.85$, $p < .07$. Subjects' responses to a subset of questions from the Duke OARS (1975) regarding their health status indicated that only 4 young adults and 3 older adults rated their health as “fair,” with the remainder of both groups describing their health as “good” or “excellent.” In summary, the older adults sampled were comparable to the young adults in some areas and superior in measures of verbal ability and education.

Stimulus Materials

Two lists of words were constructed for the present study. The training list consisted of 20 common female names selected from the Battig and Montague (1969) word norms. The experimental list consisted of 36 items selected from six categories (furniture, fruit, alcohol, clothing, occupations, and animals) of the Battig and Montague norms, six words per category. The six items selected from each category were chosen from the 12 most frequent items in each category.

Design

The design was a 2 × 2 × 2 between-groups factorial. Age (young and old), encoding condition (presence or absence of a divided attention task), and retrieval condition (presence or absence of a divided attention task) were between-subjects variables. There were 15 or 16 subjects in each between-groups condition.

Procedure

Prior to beginning the experiment, the experimenter administered the forward and backward digit span test from the Wechsler Adult Intelligence Scale, measured visual acuity, and obtained some basic health and demographic information about each participant. The Gardner and Monge Word Familiarity Survey was administered to each subject at the end of the experimental session. Subjects were tested individually. The entire session, including debriefing, lasted approximately 1 hr.

Subjects were assigned to one of four encoding retrieval combinations defined by the presence or absence of a divided attention task at the time they either studied or recalled words. Subjects in the control condition encoded and recalled with no divided attention task present at either stage of the experiment. Subjects in the divided/nondivided condition studied words during encoding while simultaneously performing a number-monitoring task but recalled words with no divided attention task present. Subjects in the nondivided/divided condition studied the words under full attention at encoding and then both recalled the words and performed the number-monitoring task during retrieval. Finally, subjects in the divided/divided condition both studied and recalled words while performing the number-monitoring task.

Training

All subjects participated in a training session with the same encoding/retrieval demands that they would experience in the experimental session. All subjects were presented with 20 common female proper names at a 5-s rate on a microcomputer screen. The words appeared in large characters (11 mm tall) so that they could easily be read by all subjects. They were instructed to study the words so that they could remember them later. In addition, all subjects were trained in a number-monitoring task, which they were to perform simultaneously with studying the names. The number-monitoring task is similar to that used by Rabinowitz et al. (1982) and Park, Puglisi, and Smith (1986) with older adults. Two-digit numbers were presented via a tape recorder at a 2-s rate. Subjects were given a small, hand-sized beeper. They were instructed to listen to the numbers played on the tape-recorder and to “beep” by pressing a button each time they heard an odd number (even for half of the subjects). Some practice (45 s) was given on this task alone. After beeper practice, subjects studied the 20-word practice list. Subjects in the divided/nondivided and divided/divided conditions began studying the list after they had been number monitoring for a short time (15 s). As in previous studies, subjects were instructed not to make any errors on the monitoring task and to consider this as their primary task, but at the same time to try to study the words and to remember them as best they could. Although subjects in the control condition were instructed in the number-monitoring task and practiced it, they did not perform the task during list presentation or during retrieval. After the words were presented, there was a brief filled interval (a subtraction task in which subjects were given a three-digit number and asked to continuously subtract sevens from their most recent response until told to stop), and then subjects received instructions for retrieval. Control subjects and subjects in the divided/nondivided condition were asked to recall as many words as they could aloud, whereas subjects in the nondivided/divided or divided/divided conditions were instructed to begin number monitoring, and after 15 s, were signaled to begin to recall. Subjects in the divided/divided conditions were instructed to respond to even numbers if they had previously responded to odd numbers or vice versa, counterbalanced across subjects. They were again reminded to make no mistakes on the number-monitoring task. At the close of the training session, all subjects were familiar with the requirements of the different phases of the experiment. No subjects evidenced any problems in understanding and adapting to the task demands in the experimental phase of the experiments.

Experimental procedure

The experimental session was identical to the training session, except that subjects were now presented with 36 words, 6 from each of six categories, randomly interspersed. They were not instructed that the words would be categorized, nor were they provided with any category cues at recall. The interval between encoding and retrieval was 2 min, during which time subjects performed a subtraction task. All responses were made verbally within a 2-min period and were recorded by the experimenter. Errors on the number-monitoring task were also recorded but occurred quite infrequently. There were 98 two-digit numbers presented at encoding, while 68 numbers were presented at retrieval. The number of errors that occurred at encoding for young and old respectively was .69 (less than 1%) and .99 (1%). For retrieval, the number of errors was .59 (less than 1%) and 1.07 (1.6%).

RESULTS

There were four analyses of variance conducted on the recall data which included the (a) total number of items recalled, (b) the number of categories recalled, (c) the number of items per recalled category, and (d) an overall measure of categorical clustering. In each of these analyses, the independent variables were age, encoding condition (nondivided or divided), and retrieval condition (nondivided or divided). Analyses of covariance using digit span scores and verbal ability scores were also conducted and did not alter the pattern of findings. All reported effects are significant at the .05 level.

Number of Words Recalled

This analysis yielded a significant main effect of age, $F(1, 118) = 23.52$, with means of 15.51 and 11.68 for young and old, respectively. There was also a significant main effect of encoding, $F(1, 118) = 103.53$, resulting from subjects' lowered performance in the divided attention condition (9.57) compared with the control condition (17.62). The retrieval main effect was also significant, $F(1, 118) = 20.92$, again because subjects recalled fewer items in the divided (11.79) compared with the control conditions (15.40). There was one significant interaction, Age × Encoding, $F(1, 118) = 3.61$. The interaction reflected a smaller difference between young and old subjects in the control condition (means of 18.78 and 16.47, respectively) than in the divided attention conditions (means of 12.25 and 6.89, respectively). The recall data are displayed in Table 1.

Table 1

Experiment 1: The Effect of Age and a Digit-Monitoring Task Present at Encoding and/or Retrieval on Memory

		Memory measure							
		Free recall		Categories recalled		Words/category		Clustering	
Encoding/retrieval condition	Age	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Nondivided Nondivided	Young	22.06	3.61	5.81	.40	3.75	.61	.44	.33
Nondivided Nondivided	Old	17.81	6.61	5.25	1.12	3.30	.93	.52	.20
Nondivided Divided	Young	15.50	4.84	5.31	.87	2.96	.96	.39	.20
Nondivided Divided	Old	15.13	2.92	5.27	.59	2.80	.64	.47	.14
Divided Nondivided	Young	13.69	4.09	5.25	.86	2.61	.65	.31	.12
Divided Nondivided	Old	8.06	5.09	3.56	1.26	2.04	.73	.23	.21
Divided Divided	Young	10.81	3.47	4.69	.87	2.26	.52	.22	.15
Divided Divided	Old	5.73	3.77	3.07	1.39	1.75	.70	.12	.24

Experiment 1: The Effect of Age and a Digit-Monitoring Task Present at Encoding and/or Retrieval on Memory

Number of Categories Recalled

In this analysis, the number of different categories accessed by individual subjects in their recall protocol (maximum of 6) was analyzed. The analysis mirrored the findings reported for total recall (see Table 1). All three main effects were significant. Young adults accessed more categories than old adults, $F(1, 118) = 32.05$, with means of 5.26 and 4.29. More categories were accessed in the control condition than when the divided-attention task was present at both encoding (means of 5.41 and 4.14), $F(1, 118) = 53.81$, and retrieval (means of 4.97 and 4.58), $F(1, 118) = 4.96$. Additionally, a significant Age × Encoding interaction occurred, $F(1, 118) = 15.23$, and it was of the same form as for total words recalled. That is, the difference between young and old adults in the number of categories accessed was smaller under control conditions (means of 5.56 for young and 5.26 for old) than under divided attention conditions (4.97 for young and 3.31 for old).

Number of Items per Recalled Category

For each category that was recalled, the mean number of items recalled (maximum of six) was calculated for each subject and analyzed. This analysis yielded only three main effects and no interactions. Again, young performed better than old (means of 2.89 and 2.47), $F(1, 118) = 10.75$. Both groups of subjects recalled more items per category under control conditions compared with when the divided attention task was present at encoding (means of 3.20 and 2.16), $F(1, 118) = 63.34$ or compared with when it was present at retrieval (means of 2.92 and 2.44), $F(1, 118) = 13.82$. The Age × Encoding interaction which appeared in the two previous analyses did not approach significance, $F(1, 118) = .74$.

Clustering Analysis

A clustering score was derived for each subject to assess the extent to which items from the same category were recalled together. Puff (1982) presented a clustering measure (ARC) which includes a correction for differences in the absolute number of items recalled. The formula for calculating the scores was

$$\mathrm{ARC} = (R - E(R))/(T - E(R)),$$

where R = the number of times a category member follows a member of the same category; E(R) = the sum of each category recall squared divided by total recall and then quantity minus one; and T = total recall. The analysis yielded two main effects and one interaction, as presented in Table 1. The main effect of age did not approach significance ($F = 0.02$). However, the main effect of encoding was significant because of greater clustering under control (0.46) compared with the presence of divided attention at encoding (0.22), $F(1, 118) = 39.36$. The retrieval main effect was significant, $F(1, 118) = 4.07$, and of a similar form with means for control and divided conditions of .37 and .30. Finally, age interacted with encoding, $F(1, 118) = 5.58$, because old subjects showed a greater drop in clustering as a function of divided attention (means of 0.50 vs. 0.18) for nondivided and divided compared to young (means of 0.42 vs. 0.27) for nondivided and divided).

Discussion

The findings of this experiment can be summarized as follows. First, there was evidence that old subjects remembered fewer items than young subjects and that subjects performed worse in conditions which included the distractor task, whether it occurred at encoding or retrieval. Second, the presence of a number-monitoring task at encoding produced an age interaction. That is, older adults' performance at retrieval declined more than young subjects' when the number-monitoring task was present at encoding. This interaction was significant for the number of words recalled, the number of categories accessed, and the categorical clustering measure. Because both category access and categorical clustering are typically considered strategic measures of organization, the results suggest that the presence of the distractor task at encoding acted to disrupt the organizational processes of older adults more than of young adults. Because searching a category once it is accessed is not an encoding function, the presence of the secondary task at encoding did not affect the number of items recalled per category.

The failure to find even suggestive evidence for an Age × Retrieval distraction interaction was somewhat surprising, particularly in light of Craik and McDowd's work indicating that recall is significantly more effortful for old adults than young adults. If recall is more effortful for older adults, the distracting task at retrieval should have disadvantaged them more than younger adults. Perhaps the use of the free recall task was problematic in this experiment. A comparison of the demands that occurred at encoding with the demands at retrieval suggests that this may be the case. During encoding, subjects had 5 s to view each item and could not spend extra time on any item if distracted by number monitoring. However, during retrieval, subjects were not stepped through the task in this fashion and had more control of the situation. They could more conveniently pause in their recall output and switch to number monitoring, something that could not occur as readily at encoding because of the 5-s presentation rate of the items. No subject required the full 2 min to recall all of the words they remembered. Thus, it appears that the predicted interaction may have failed to emerge because of the use of the somewhat unstructured free recall task. To test this hypothesis, Experiment 2 was conducted. In this experiment, subjects were presented with a cued recall task rather than a free recall task, and the cues were presented during retrieval at a rapid 3-s rate. Subjects had a very brief period of time in which to make a response, and there was less of an opportunity for recall strategies to manifest themselves. Thus, Experiment 2 was designed to have greater sensitivity to age differences than Experiment 1.

EXPERIMENT 2

In addition to changing the retrieval task from Experiment 1, the encoding and retrieval manipulations, which were between-groups manipulations in Experiment 1, were made within-subjects variables in Experiment 2. The primary reasons for this were simply to increase efficiency and to enhance the sensitivity of the dependent measures.

Method

Subjects

A total of 32 subjects participated in this experiment, 16 young adults and 16 older adults. The young adults were undergraduate psychology students participating to receive course credit. The older adults were 60 years old or older and were temporary winter residents of an affluent Florida condominium village, with their permanent residences primarily in the Midwest and Canada. They were paid $10 for their participation. The mean age of the young adults was 18.81 years, and the mean age of the old adults was 67.31 years. There were 15 females and 1 male in each age group. All 16 young participants and 15 elderly participants rated their health as good or excellent. Additionally, 1 elderly participant rated her health as fair. The vocabulary score on the Gardner and Monge 30-point Word Familiarity Survey was 14.62 for the young and 19.00 for the old, a significant difference, $t(30) = 2.19$, $p < .05$. The attained educational level of the elderly adults was somewhat lower than that of the Athens sample described in Experiment 1, with reported levels as follows: college education or graduate degree = 25.1%; some college education = 18.8%; high school graduate = 25%; less than high school = 31.1%. Subjects were also screened for visual acuity.

Stimulus materials

There were two sets of stimulus materials: a training set and a test set. The training set consisted of 32 word pairs drawn from Flavell (1961). Each pair consisted of a cue and a target, with the target item being a weak associate of the cue. The 96 test item pairs were similarly constructed by using the Postman and Keppel (1970) word norms. The target item was the seventh most frequent association to the cue. Examples of cue/target pairs are *lion/hunter* and *dark/closet*. The 96 items were distributed across four test lists, and the frequency of targets across the four lists was equated by using the Carrol, Davies, and Richman (1971) norms.

Design

The design was a mixed 2 × 2 × 2 design with age as the between-groups factor and the presence or absence of the number-monitoring task at encoding and at retrieval as a within-subjects factor. Counterbalancing occurred for the order in which the four different lists of words were presented and for the order of the four encoding/retrieval combinations across the 16 subjects.

Procedure

All subjects were tested individually. The total procedure took about 1 hr and 15 min. Prior to beginning the experimental session, subjects were trained in all four conditions in the same order in which they would participate in the test phase of the session. Training in the use of the beeper and the number-monitoring task, as described in Experiment 1, occurred first. During the training session, subjects studied four lists of word pairs, each consisting of eight items. After each list was presented, subjects performed the subtraction task briefly and then received the eight cues at a 3.5-s rate for recall. Subjects performed the number-monitoring task as appropriate for each study/test condition so that they had been trained in all four conditions before the test phase of the experiment. As in Experiment 1, following training, the word pairs were presented during encoding at a 5-s rate for the test phase of the experiment. The apparatus was the same used in Experiment 1. During retrieval of the four test lists, rather than a free recall task, subjects were presented with the individual cues (reordered from encoding) and had 3 s to say the word they had studied with the cue. The experimenter recorded their responses, as well as any beeper errors that were made in relevant conditions.

RESULTS

A repeated measures analysis of variance was conducted on the number of items correctly recalled, with age, encoding condition, and retrieval condition as factors. The analysis mirrored those reported earlier in Experiment 1, regardless of whether the verbal score was used as a covariate. There was a main effect of age, $F(1, 30) = 26.16$, as young recalled more words than did old. The main effects of encoding condition, $F(1, 90) = 123.19$, and retrieval conditions were both significant, $F(1, 90) = 14.78$, because memory was poorer when the divided attention task was present. As in Experiment 1, there was an Age × Encoding interaction, $F(1, 90) = 4.41$. The difference between young and old was larger when the divided attention task was present at encoding compared to when it was not, as shown in Table 2. The expected Age × Retrieval interaction did not approach significance, with an F value of less than 1.0. Finally, there was a significant Encoding × Retrieval interaction, $F(1, 90) = 5.63$. The addition of the divided attention task at retrieval caused a decline in performance when the nondivided/nondivided, that is, the control condition, (mean of 17.93) is compared with the nondivided/divided condition (mean of 14.38). However, the inclusion of the divided attention task at retrieval had no effect if subjects' attention had already been divided at encoding, with means for the divided/nondivided and divided/divided of 10.22 and 9.37, respectively. In other words, adding divided attention at retrieval did not make performance significantly worse if attention was already divided at encoding. As in Experiment 1, error rates for the number-monitoring task were low. Across the four conditions (in which all subjects participated), a total of 223 digits were presented to each subject. The mean number of monitoring errors made was 4.25 for the young (1.9%) and 2.9 for the old (1.32%).

Table 2
Experiment 2: The Effects of Age and a Digit-Monitoring Task Present at Encoding and/or Retrieval on Number of Words Recalled

Encoding/retrieval condition	Age			
	Young		Old	
	M	*SD*	*M*	*SD*
Nondivided/nondivided	20.25	2.73	15.62	3.90
Nondivided/divided	16.44	3.10	12.31	4.57
Divided/nondivided	13.44	4.66	7.00	4.06
Divided/divided	12.94	4.91	5.81	3.88

Experiment 2: The Effects of Age and a Digit-Monitoring Task Present at Encoding and/or Retrieval on Number of Words Recalled

DISCUSSION

The similarity of these data to those of Experiment 1 is quite striking, particularly given that the stimuli were different, the memory task was changed, the elderly subjects were less educated, and the critical manipulation was now within subjects rather than between groups. It suggests that the effects observed in Experiment 1 are reliable. The purpose of the cued recall task in Experiment 2 was to constrain the time-sharing strategies at retrieval in a manner similar to the time sharing at encoding by using a paced presentation of the words at both encoding and retrieval. By pacing the cues at retrieval, task demand characteristics at retrieval were similar to those at encoding. Moreover, the pattern of results in Experiment 2 cannot be attributed to the use of an easier cued recall task, instead of the free recall task used in Experiment 1. An examination of recall performance in the nondivided/nondivided condition across the two experiments suggests that the cued recall task in Experiment 2 was actually more difficult than the free recall task in Experiment 1. A total of 36 target items was presented in Experiment 1 and only 32 in Experiment 2. However, the proportion recalled is the same for the two experiments in the control conditions, with mean recall of .55 in Experiment 1 and .56 in Experiment 2, despite the shorter list in Experiment 2.

GENERAL DISCUSSION

The results of these two experiments suggest that the addition of a divided attention task at encoding has a more deleterious effect on verbal recall of older adults than of younger adults. This finding is consistent with those reported by McDowd and Craik (1988), Salthouse et al. (1984), and others, for working memory tasks. The more interesting finding, however, was that there was little evidence to indicate that older adults' performance declined more than that of young adults when the divided attention task occurred at the time of retrieval in either free recall or paced cued recall. This is a surprising finding, given the evidence that retrieval is particularly difficult for older adults. For example, both Macht and Bushke (1983) and Craik and McDowd (1987) presented evidence suggesting that recall is quite effortful (i.e., demanding more processing resources) for elderly adults. If retrieval does place a greater strain on the processing abilities of old relative to young, the number-monitoring task during recall should affect older adults more than younger adults. Although this effect was shown for encoding, it was not shown for retrieval, even though the results clearly showed that the secondary task was effective in significantly reducing recall in both age groups.

At the same time, these data are consistent with those reported by Gick et al. (1988) and Morris et al. (1988). Gick et al. had subjects perform a sentence verification task and in some instances remember the final word from each sentence (divided attention). In this working memory paradigm, increasing sentence complexity did interact with age, as expected. Adding the divided attention task, however, to sentence verification or increasing the set size of the memory load did not interact with age. Similarly, Morris et al. found that sentence complexity, but not memory load, affected elderly more in a sentence verification task. In both studies, the authors suggest that their findings are damaging to general resource views of processing capacity and to the notion that there are general, age-related decrements in the cognitive system. They conclude that further research is needed to understand the conditions under which divided attention interactions with age do and do not occur. Morris et al. propose that perhaps older adults do not have trouble holding and rehearsing items in working memory but that the processing of new information declines with age. The present data do not directly address this explanation because they relate to a long-term memory paradigm. However, like the findings of Morris et al. and Gick et al., the present data do not support any hypothesis which suggests that older adults suffer from a general deficiency in processing information. Such a hypothesis predicts that older adults would be more greatly affected by any variable that reduces the performance of younger adults because they have reduced processing resources. In other words, conditions that reduce the memory performance of younger adults should produce amplified effects on the memory performance of older adults. In the present data, the divided attention task during retrieval reduced the recall performance of younger adults. In two different experiments, however, older adults and younger adults were affected by divided attention during retrieval in the same way. The retrieval processes of old and young are not differentiated by the addition of interference.

It is possible that the interaction would emerge if latency measures were used as the dependent measure. Macht and Bushke (1983) and Craik and McDowd (1987) argue that recall is more effortful for old than young. In fact, Craik and McDowd, as in many other studies, do report an interaction of age with retrieval task (recognition vs. recall). In both of these studies, the observed decline was in response latency. Perhaps the present procedure would yield an age interaction if latency to respond on the cued recall task were measured. That is, older adults would be slowed significantly more in their response time to a retrieval cue when the divided attention task was added compared with young adults. However, even if this were to occur, it is still surprising that the absolute level of recall is unaffected, and it is also an important finding with respect to everyday memory functioning, where millisecond differences are of little import.

It also is important to recognize that amount of effort required on a cognitive task, as measured by latency data, may not be the best predictor of memory performance. Zacks, Hasher, Sanft, and Rose (1983), in five different experiments, failed to find a reliable relation between effort expended at encoding and later memory performance.

We have suggested some reasons for not finding an Age × Retrieval interaction; we also might note that our own intuitions, as well as anecdotal evidence collected in our laboratory provided strong expectations that such an interaction would occur. Older adults who visit our laboratory invariably report, independent of any questioning, that they have difficulty retrieving words or pulling up information—especially names—that they know they have stored in memory. The present results suggest that perceived retrieval difficulty on the part of older adults is not necessarily due to increased distraction or the inability to focus on the retrieval act. It is possible that the reports merely reflect a slowing of the retrieval system, rather than a qualitative difference in the way retrieval processes function in young and old. If this is the case, the present data are an accurate mirror of our participants' subjective experiences because the older adults generally did recall fewer words than did young adults.

In terms of everyday memory functioning, the present data have both positive and negative implications. On one hand, it appears that if older adults are distracted or disrupted at the time they are encoding information, such as listening to a set of directions over the phone, they will be more disadvantaged by a distracting question or concurrent event than will a young adult. However, if the distraction occurs at the time of retrieval, such as when one is trying to remember what they are to buy at the grocery store, they will be disrupted, but no more disrupted than a young adult. Further research to address the generality of the observed effects is clearly warranted.

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